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An assessment on the current status and future of wind energy in Turkish electricity industry☆

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ABSTRACT

Promotion of renewable energy sources is a widely adopted policy since they are accepted to positively contribute to ensure the security of energy supply, mitigate CO_2 emissions and meet the increasing energy demand. In parallel with that global thought, wind energy has been a hot topic in Turkish energy agenda although the share of wind energy in total energy resources of the country is still low. In this framework, the policies and applications regarding wind energy in Turkey are examined, the short-term and long-term priorities are evaluated and some suggestions are provided in this paper.

Contents

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1. Introduction

The level of interest in the generation of electricity by use of renewable energy sources has increased as a result of some emerging issues such as the concerns about the security of energy supply and the rising consciousness about environment and CO_2 emissions. Wind energy has been one of the significant renewable energy alternatives with its potential to reduce CO_2 emissions and dependence to abroad as wind energy technology has been substantially developed in recent years.

The roots of the interest in wind energy may be found in oil crises in 1970s. Some countries were focused on wind energy as an alternative and they invested significant amount of financial resources to the wind turbine technology due to the rapidly increasing oil prices. Furthermore, the increasing concerns for the environmental degradation have encouraged the research on renewables. The wind technology has significantly improved as a result of the increasing interest, concern and research activities.

Electricity generated from wind is more costly than that generated from fossil fuels although the cost difference has been getting smaller. Therefore, most of the countries prefer implementing some methods and subsidies to allure the investment on wind energy. With the development of technology and engineering of wind energy and the promotion schemes, recent years have been the golden years of wind energy in the world.

Turkey gives prior importance to renewable energy sources as the country is a net energy importing country. Approximately half of the electricity has been generated by natural gas almost all of which has been imported. Renewable energy is a significant alternative providing Turkey with the opportunity of diversifying the resources and improving the security of supply of electricity.

The accession negotiations between the European Union (EU) and Turkey were opened in 2005 and Turkey endeavors to be a full-member of the EU. Hence, the priorities and goals of the EU also affect Turkey. Supporting renewable energy sources is one of the fundamental issues in the agenda of the EU. One of the main targets of the energy policy of the EU is having 20% weight of renewables in total energy by 2020. That may be evaluated as another motive forcing Turkey to improve its energy generation by renewables.

The amount of electricity generated by wind energy in Turkey was negligible until recent years. However, the investments on wind energy facilities have substantially increased and the installed capacity of these facilities has rapidly improved in recent years. It is apparent that the trend will continue in the future and the wind energy will be one of the prominent alternatives in Turkish energy industry.

Most of the studies on the renewables or wind energy in Turkey are concentrated on the wind energy potential of Turkey, the status of wind energy in Turkish electricity market or technical properties and predictions regarding wind energy. Some of those studies focus on some regions of Turkey. For instance, Akpinar and Akpinar used the Weibull density function to determine the wind energy potential in Maden-Elazig [1]. Eskin et al. estimated wind energy potential of Gökçeada Island [2]. Sahin et al. investigated the wind energy potential in the eastern Mediterranean region [3]. Onat and Ersoz used computer software programs to determine the characteristics of wind climate and energy potential of Samandağ, Amasra and Güney regions in Turkey [4]. Ucar and Balo analyzed wind characteristics of Erzurum, Elazığ, Bingöl, Kars, Manisa and Niğde [5]. Ozgener investigated the wind energy potential of Celal Bayar University Muradiye Campus in Manisa [6]. Arslan investigated the ability of Kütahya for electricity generation from wind energy [7]. Celik investigated the wind energy potential of Çanakkale [8]. Ucar and Balo investigated wind characteristics and wind energy potential of Uludağ-Bursa [9]. Some other studies investigate the wind energy potential of Turkey or status of wind energy in the country [10–14].

The studies including assessments of or suggestions for Turkish renewable (and wind) energy policy are generally focus on broader policy issues and do not present detailed analysis of Turkey's renewable energy policy. One of the main goals of this paper is to put an end to the lack of that kind of studies.

This paper is organized as follows. Current status of wind energy in Turkey is presented in Section 2. Section 3 summarizes current Turkish legislation on wind energy. Section 4 focuses on the reasons motivating Turkey to increase its wind energy capacity. Wind energy policy of Turkey is discussed and assessed including opportunities, challenges and future perspectives in Sections 5 and 6. The concluding remarks are drawn in Section 7.

2. Current status of wind energy in Turkey

As displayed in Table 1, Turkey is the 19th largest wind market of the world with its 796.5 MW installed wind energy capacity at the end of 2009. The growth rate of the year 2009 is 139% which makes Turkey having the second biggest growth rate in the OECD members after Mexico which has 373% growth rate [15]. Turkey's growth rate in 2009 is more than 4 times of that of the total wind energy capacity of the world.

It is claimed in some papers that the country having the highest technical wind energy potential in Europe is Turkey. As shown in Table 2, Turkey's technical wind energy potential is 166 TWh/year [16,17]. However, the data shown in the table does not provide perfectly healthy numbers. For example, the wind energy capacity of Germany is 25,777 MW at the end of 2009 which is almost 100% higher than that shown in the table. In addition, it is estimated that economical wind energy potential of Turkey is 10,000 MW depending on the technical conditions [12,18].

Even though Turkey has an important potential of wind energy and has a rapidly growing wind energy capacity, the share of wind energy in the total installed capacity is still so low. The share of wind energy capacity was only 0.8% of the total installed capacity according to 2008 data. However, the current share of wind energy in the total installed capacity is 2.9% with a capacity of 1484 MW thanks to rapid growth [19]. Nevertheless, this capacity is so low to reflect the overall potential of the country.

Ernst and Young issues a periodical paper on renewable energy and wind energy attractiveness indices of countries. These country attractiveness indices provide scores for national renewable energy markets, renewable energy infrastructures and their suitability for individual technologies. The highest score is 100. The wind index is the long term index whereas the near-term wind index reflects a two-year view. The near-term index is based on the parameters of most concern to an investor aiming to make a near-term investment. These parameters include power offtake attractiveness, tax climate, resource quality, market growth potential and project size. The long term wind index is derived from 70% of the onshore wind index and 30% of the offshore wind index. According to these indices Turkey is ranked in 26th place at long term wind index with a 43 index value as February of 2011 (Table 3). Turkey's near-term wind index is calculated as 32 which determines Turkey's rank as 22 [20].

3. Current Turkish legislation on wind energy

The main Turkish legislation on renewable energy in which wind energy also included is the Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (Law Number 5346). This law was enacted on 18 May 2005. The purposes of the law are stated as to expand the use of renewable energy sources for generating electrical energy, to benefit from

Table 1
Wind energy capacities of the countries.

Position 2009	Country	Total capacity end 2009 (MW)	Growth rate (2009) (%)	Position 2008	Total capacity end 2008 (MW)
1	USA	35,159	39.3	1	25,237
2	China	26,010	113.0	4	12,210
3	Germany	25,277	7.9	2	23,897
4	Spain	19,149	14.7	3	16,689
5	India	10,925	14.0	5	9587
6	Italia	4850	29.8	6	3736
7	France	4521	32.8	7	3404
8	UK	4092	28.1	8	3195
9	Portugal	3535	23.5	10	2862
10	Denmark	3497	10.6	9	3163
19	Turkey	797	138.9	25	333
Total		159,213	31.7		120,902

Source: WWEA [15].

these resources in secure, economic and qualified manner, to diversify energy sources, to reduce greenhouse gas emissions, to assess waste products, to protect the environment and to develop the related manufacturing sector for realizing these objectives. Some incentives to increase the use of renewable energy including wind energy are introduced in this law.

The law was amended at the end of 2010 and the amendment is published on 29 December 2010. A new structure is envisaged with the amendment. However, the new renewable support scheme and structure is planned to be implemented on 1 December 2011.

The first incentive for the use of renewable energy was the obligation of retail sale licensees to purchase electricity from renewable energy sources. According to the law, each legal entity holding a retail sale license had to purchase renewable energy source-certified electrical energy in an amount declared by Energy Market Regulatory Authority (EMRA). However, when the amendment comes into effect on 1 December 2011, all the suppliers will be obliged to purchase electricity from renewable energy sources. The suppliers will not need to sign bilateral contracts with the generators directly. The market operator will buy the renewable energy directly from the producers who accept to participate in the new renewable support mechanism. The total cost (or benefit) will be shared by all of the suppliers and the settlement process will be managed by the market operator.

Secondly, the law determined a price floor and a price ceiling for the electrical energy purchased within the context of the law. It was stated in the law that, the applicable price for the electrical energy to be purchased in pursuance with the law within each calendar year should be the Turkish average wholesale electricity price in the previous year determined by EMRA. However, the price range was limited to be between 5 and 5.5 Eurocent/kWh. If the generators might sell their electricity in exchange for a price higher than 5.5 Eurocent/kWh, they did not have to sell their electricity within the context of the law. They had the right to sell their energy in the market. This mechanism has also been removed by the amendment on 29 December 2010. The feed-in tariff for the electrical energy purchased within the context of the law has been redefined and differentiated according to the type of the resource. The new tariff for the energy generated from wind is determined as 7.3 US cent/kWh.

Another incentive introduced in the law is related to acquisition of land. According to the law, in case of utilization of all sorts of property which is under the possession of Forestry or Treasury or under the sovereignty of the State for the purpose of generating electrical energy from the renewable energy sources in the scope of this Law, these territories are permitted on the basis of its sale price, rented, given right of access or usage permission by Ministry of Environment and Forestry or Ministry of Finance. Besides, it is stated that 85% deduction shall be implemented for permission, rent, right of access and usage permission in the first ten years of the investment period.

It is hard to claim that at least first two of these three main incentives have served in consistence with their aims. The major reason limiting these incentives is that the price level of 5 or 5.5 Eurocent/kWh has been lower than the system imbalance prices constituted in the balancing and settlement market. Furthermore, until recent times, the level of Turkish average wholesale electricity price in the previous year determined by EMRA also has been lower than the system imbalance prices in the balancing and settlement market. Therefore, the generators have preferred selling

Table 2
Technical wind potential of some European countries.

Country	Potential (MW)	Potential (TWh/year)
Turkey	83,000	166
UK	57,000	114
Spain	43,000	86
France	42,000	85
Norway	38,000	76
Italy	35,000	69
Greece	22,000	44
Ireland	22,000	44
Sweden	20,000	44
Iceland	17,000	34
Denmark	14,000	29
Germany	12,000	24
Portugal	7000	15
Finland	4000	7
The Netherlands	3000	7
Austria	2000	3
Belgium	2000	5
Switzerland	1000	1
Luxemburg	0	0

Source: Van Wijk and Coelingh [16] and Kenisarin et al. [17].

Table 3
Wind indices of Turkey.

Term	Wind index		Near-term wind	
	Rank	Index	Rank	Index
February 2011	26	43	22	32
November 2010	28	42	22	32
August 2010	23	43	22	32
May 2010	23	43	21	32
February 2010	23	42	21	32
November 2009	23	43	19	33
May 2009	23	43	19	33
March 2009	23	43	18	33
Quarter 3 2008	23	38	21	31
Quarter 1–2 2008	23	37	22	31

Source: Ernst and Young [11].

Table 4
Additional incentive for domestic production of equipment for wind energy.

Domestic production	Domestic contribution (UC cent/kWh)
Wing	0.8
Generator and power electronics	1
Turbine tower	0.6
All of the mechanical equipment in rotor and nacelle groups (excluding payments made for the wing group and the generator and power electronics)	1.3

their energy in the balancing and settlement market rather than within the context of the law. Hence, even though an expansion in the wind energy capacity has been observed, explaining this expansion by market conditions rather than by the incentives introduced in the law would be more valid. Since the ineffectiveness of the law in promoting renewable energy has been recognized, the law was amended in December, 2010.

Electricity Market Licensing Regulation is another important piece of legislation including provisions about renewable energy sources. In this regulation, some incentives are introduced. The regulation states that the legal entities applying for licenses for construction of facilities based on domestic natural resources and renewable energy resources shall only pay one percent of the total licensing fee. Besides, the regulation has a provision stating that the generation facilities based on renewable and domestic energy resources shall not pay annual license fees for the first eight years following the facility completion date inserted in their respective licenses. Furthermore, according to a provision in the regulation, Turkish Electricity Transmission Company (TEIAS) and/or distribution licensees shall assign priority for system connection of generation facilities based on domestic natural resources and renewable resources.

The amendment in the end of 2010 not only introduced different tariffs for different sources, but also determined additional incentive for domestic production. The additional incentive will be paid five years to the plants commissioned before 31 December 2011. Table 4 shows additional incentive for domestic production of equipment for wind energy.

Finally, a new regulation has been enacted on 3 December 2010 allowing the renewable generators with an installed capacity lower than 500 kW to install the generation facilities without obtaining a license. Those kinds of generators also do not have to found a firm according to the new regulation defined by EMRA.

4. Should Turkey increase its wind energy capacity?

As seen in Fig. 1, the share of natural gas in the electricity generation of Turkey has been substantially increasing. Furthermore, nearly 97% of the natural gas is imported and the ratio of the natural gas imported from Russia is very high. Hence, it is apparent that Turkey has to find out some means to decrease its dependency to natural gas and it has to diversify the energy sources. Thus, the diversification of primary energy sources has been one of the objectives of the Turkish government in the electricity sector [21]. The share of renewables in total primary energy supply of Turkey was only 6.4% in the year 2004 [22] showing how increase of renewables may improve the security of energy supply of the country. Within this context, wind energy appears as a significant alternative since it is totally domestic and has a significant non-deployed potential.

The rapidly growing electricity demand is another major reason pushes Turkey to deploy various energy sources. It is expected that the electricity demand will increase with an annual growth rate of 7.7% until 2020 [21]. Although the electricity demand was declined in 2009 as a result of global economic crisis, the trend of increasing electricity demand is envisaged to continue. Hence, Turkey has to increase its wind energy capacity as well as other renewables' capacity to be able to meet that increase in the electricity demand.

The concern for environmental issues is also one of the motives driving Turkey to use renewables including wind. Since 1970s it has been widely accepted that environmental degradation is a significant menace for sustainable development. The Kyoto Protocol to the United Nations Framework Convention on Climate Change which was agreed in 1997 may be assessed as a result of the rising concern for environmental degradation. Promotion of renewable energy has been evaluated as an important policy to be able to deal with climate change and reduce greenhouse gas emissions [23]. Although Turkey did not accept to sign the Kyoto Protocol for a long time, agreement to sign the protocol was ratified by Turkish Parliament in February of 2009 and the protocol was signed in May of 2009. Furthermore, support of renewable energy sources is one of the pillars of the EU's energy policy. Although Turkey is not a member of the EU for now, it is a country having negotiations for accession and it cannot stand fully outside of the policies of EU. Therefore, it may be claimed that those international factors lead Turkey to invest in renewable energy to fight with climate change and to decrease greenhouse gas emissions.

Even though international concerns and agreements may be neglected, Turkey should be aware about the greenhouse gas emissions since the amount of its greenhouse gas emissions has been substantially increasing. As displayed in Table 5, the main sector behind the increasing greenhouse gas emissions is the energy sector. The most significant source leading to greenhouse gas emis-

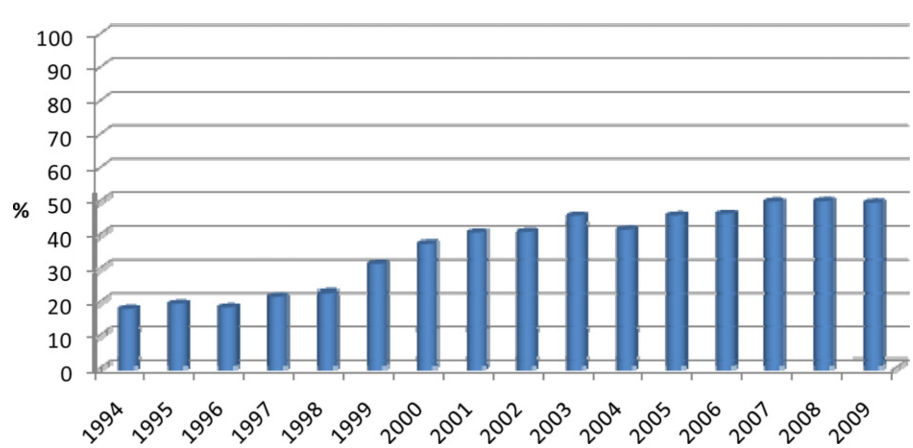


Fig. 1. The share of natural gas in total electricity generation of Turkey (%).

Table 5
GHG emissions in Turkey (in millions tons of CO_2 equivalent).

	1990	1995	2000	2005	2007
Energy sector emissions	132	161	213	24	288
Total emissions	170	221	280	312	373

Source: Erdogdu [24].

sions is the energy production with the share of 77.4% in 2007 [24]. Therefore, Turkey needs to take some steps, starting from the energy industry, at least to reduce the growth rate of greenhouse gas emissions. However it should be noted that, according to 2007 data, Turkey is ranked as the 85th country in per capita CO_2 emission with the value of 3.95 metric tons while it is ranked as the 22nd country in total CO_2 emissions with approximately 1% share of global emissions [25]. Thus, Turkey should pursue a policy which establishes a balance between greenhouse gas emissions and development.

Another contribution of renewable energy sources is their ability to create opportunities for industrial development and job creation. The number of people working in the German renewable industry was 150,000 in 2005 80,000 of which were working in the wind sector. The number of people employed in the Danish wind industry is approximately 20,000 [26]. Therefore, a concrete policy not only promoting wind energy utilization but also creating a nature for development of technology may foster economic activities regarding renewables.

5. On the wind energy policy of Turkey: short-term priorities

5.1. Determination and structure of the support mechanism

It is generally accepted that government involvement is essential to ensure the development of renewable energy technologies in the emergence phase of those technologies. The necessity stems from the pursuit to protect those technologies from direct competition with conventional technologies [27]. As a result, a wide range of methods and policies have been used to promote the utilization of renewable energy. These policies include pricing laws, quota requirements, production incentives, tax credits and trading systems [26]. Two types of these policies have appeared as the major renewable energy support mechanisms: The feed-in tariff (FIT) and quota mechanisms.

In the FIT method, renewable energy using electricity generators have the right to sell their electricity at a fixed tariff for a specified time period under specific conditions depending on location, technology, etc. The costs of FIT payments are generally passed on the consumers. On the other hand, in a tradable green certificate (TGC) mechanism, a defined member of electricity supply chain such as a consumer or supplier has to present a fixed minimum quantity of renewable energy certificates each year. This mechanism is a quota mechanism aiming to encourage renewable energy producers by enabling them to receive additional financial benefit from selling these certificates in the market [28]. Second common type of quota mechanism is the tendering system. In the tendering system, the government determines the amount of electricity which will be generated by each kind of renewable sources in a period of time. It also determines the maximum price per unit. Afterwards, the generators or project developers bid their prices and a tendering process is carried out. The bids of potential developers are accepted starting with the lowest bid and working upwards, until the achievement of required capacity. In tendering system, the government covers the difference between market reference price and the winning bid price [29].

Table 6
Renewable support schemes of selected EU member countries.

Country	Support mechanism
Austria	FIT guaranteed for 10 years with two additional years at a reduced rate
Denmark	Variable bonuses on top of the market for electricity, guaranteed for 10 years
France	Obligation to buy electricity from renewable energy sources at a price fixed higher than the market price (FIT) for 15–20 years
Germany	FIT guaranteed for 20 years
Greece	FIT for 10 years (can be extended)
Spain	FIT are guaranteed for 15–25 years at a fixed price and continue at a lower fixed rate thereafter
Sweden	Electricity certificate system

Source: Commission of the European Communities [30].

Whereas the price is fixed by the government and quantity is determined by the market under a FIT system, the quantity is determined by the government and prices are constituted in the market under a TGC system.

The support schemes of selected EU countries are shown in Table 6 [30]. The mostly adopted system by some EU member countries is FIT system. While the countries such as Germany, Denmark and Spain which implemented FIT systems have succeeded to increase their renewable energy capacities there has not been a great achievement in the countries which adopted quota systems.

Quota systems, especially TGC mechanisms, are generally assessed as more superior to FIT mechanisms in a market view since the price is determined by the market under those systems. Therefore, TGC system is accepted as more compatible with competitive power markets. Besides, TGC system is more likely to promote least-cost projects [29]. Another disadvantage of FIT system is its weakness in providing sufficient incentive to reduce costs. However, FIT system is more favorable for investors since the prices are pre-determined and the market risk is removed. Financing the projects in a FIT system is easier. Another advantage of FIT system is its easiness to be implemented. Furthermore, it is apparent that the countries implementing that kind of support mechanism have been more successful in deploying renewable energy sources.

Turkey has chosen FIT system to promote renewable energy including wind energy. Whereas a fixed price was determined for all kind of renewable sources in the law, the tariffs for different types of sources or technologies is differentiated with the amendment on 29 December 2010. Besides, the payment mechanism from suppliers to generators is clarified in the new system whereas it was not clear in the previous legislation.

The main drawback of FIT system for Turkey is that it is not a market solution. Actually, it may be reasonably claimed that the market may be neglected to ensure the security of supply and to contribute to achieving environmental targets. Nevertheless, it should be remembered that creating a competitive market is the first aim of the restructured Turkish electricity market. Almost 67% of the total installed electricity capacity of the country is directly belongs to the public companies or to the firms having long term contracts with the government. Furthermore, 6% of the total capacity is held by autoproducers whose main aim is not selling electricity. Implementing another support mechanism which hinders market mechanism may increase the total amount of electricity traded out of the market conditions. That is, Turkey, whose main aim is to create a competitive market, pursues a policy that precipitates a market just sheltering a small number of competing firms and a small amount of electricity trade. However, it should be mentioned that the efforts are made to be able to form the new renewable support mechanism without creating negative effects on the liberal market.

Even though FIT mechanism is accepted to hinder market competition, it has been apparently successful in promoting renewable energy in many countries. It is reasonable to believe that it will be successful in Turkey as well. So, as Turkey has implemented a FIT system, meanwhile it has to open other parties of generation to competition. Otherwise, as mentioned, an odd kind of market will be created where just a small portion of customers will be able to choose their suppliers while currently consumption of the consumers who has the right to choose their suppliers is more than the two third of total electricity consumption.

Other advantages of FIT system for Turkey are related with alluring financial resources and its easiness of implementation. The FIT system enables the investors to finance their investments more easily since many renewable energy projects are financed by national or international financial institutions. On the contrary, a TGC system may discourage the investors as the prices are volatile and inherently involve risks. In addition, FIT system may encourage small renewable source projects if it offers a profitable price for that kind of projects. Furthermore, a FIT system is easy to be implemented, managed and enforced. However, in a quota system, policy makers have to establish optimal targets which are hard to be determined. If the target is set high, the prices may be higher and if the target is set so low the prices may be pushed down. Since the targets set under the quota system are not so flexible, that may produce dramatic results [29]. Hence, implementing a quota system might be a challenge for Turkey.

The tariff for wind energy is 7.3 US cent/kWh without the additional incentive for domestically manufactured equipment. The tariff will be applicable for ten years for the power plants commissioned before 31 December 2015 if an extension decision is not taken. The price is lower than and anticipated to be lower than average market prices. Therefore, it is a matter of debate if the determined tariff is an incentive or insurance for the generators.

5.2. Licensing and coordination

EMRA is the responsible authority for licensing of applications for wind energy projects. TEIAS is the transmission company owned by the government and it is responsible for system connection of the facilities. The Ministry of Energy and Natural Resources is the main party leading energy policy of the country. Besides, there are other governmental organizations having part in some parts of the evaluation of the projects. Therefore, it is apparent that a higher level of coordination and cooperation between the institutions and agencies are very crucial for licensing and implementation of wind energy facilities. The improved coordination and cooperation is significant to ensure reliability of the policies regarding renewable energy.

There are some issues regarding licensing of the wind energy projects although some endeavors have been appeared to solve the problems. In 2007, EMRA accepted wind energy license applications in one day whose total capacity is almost twice of the total electricity installed capacity of Turkey. The assessment of those applications has taken a long time as a result of the lack of coordination between parties, the lack of a well-defined action plan and irresolution. The method how to evaluate multiple applications for the same location has just been determined after a long time of uncertainty discouraging domestic and foreign investors. Today, the method is clear and the tender and licensing process continues. However, the decision gap postponed the investment and created uncertainty in the short term.

The government's and related parties' determination for utilization of wind energy and other renewable energy sources are apparent. However, the need for a mechanism enabling more coherent and fast evaluation, licensing and implementation of projects is obvious.

5.3. Some issues regarding the balancing and settlement market

The balancing and settlement market where balancing of the system is maintained and spot prices are constituted is a crucial part of current Turkish electricity market. The balancing and settlement market consists of a day-ahead planning mechanism and a balancing power market. Day-ahead planning contains the actions carried out under the coordination of market operator in order to balance the foreseen hourly demand regarding the following day on the day ahead. A day-ahead market is envisaged to supersede day-ahead planning on 1 December 2011. The balancing power market is the organized wholesale electricity market, where the reserve capacity, obtained by the change in output power within 15 min, is sold or purchased to serve the purpose of real-time balancing of demand and supply. Marginal price system is adopted in both day ahead planning and the balancing power market. That is, the price of the last accepted bid constitutes the hourly price.

To begin with, well operation and functioning of the balancing and settlement market is very important for renewable energy generators as well as for all other parties in the market. The volume of regulations not calculated in the hourly prices were very high in the transitional balancing and settlement mechanism which had been in force until the current system was put into practice in December of 2009. Even though this high volume were assessed as beneficial for consumers since it had a downward effect on prices, it created some problems for especially renewable energy generators. The costs of the uncalculated regulations in hourly prices were distributed to all generators and had become a cost for the generators. That was not a big problem for the generators who were capable of having regulations for real-time operations since they could reflect the cost to their bids. However, wind generators are not assessed as balancing entities to be given real-time regulations. In current market, only the consumers are responsible for paying the cost of the regulations which are not calculated in hourly prices. However, if the up-ward or down-ward regulations are not given according to their real purposes and the amount of regulations not included in calculation of hourly prices is higher than the required amount, it will create an unforeseen cost parameter for especially wind energy generators. To recapitulate, a well-functioning balancing and settlement market with truly given regulations is important for renewable energy generators.

Another issue linking the balancing and settlement market to wind energy is the hourly pricing mechanism. Every hour has its own price within that mechanism. Consequently, while marginal prices of some hours are higher as a result of high demand, the others are lower. Since hourly prices will be higher than the fixed prices for renewable energy sources in some periods, a system allowing the wind generators to sell their electricity in the balancing and settlement market may be accepted as a policy. This mechanism implies that while the generators are a part of FIT mechanism, meanwhile they can sell their energy in the spot market. Otherwise, if the average of market prices becomes above the fixed prices in FIT mechanism, the power of the FIT mechanism will disappear. In that case, the FIT will function as an insurance mechanism more than a support mechanism. Therefore, most of the generators might not desire to be a part of the renewable support mechanism.

The time for gate closure can be assessed as another significant issue especially for the wind generators preferring performing out of the FIT mechanism. Short gate closure times increase accuracy of forecasting and reduce balancing costs. Since the wind energy generators can only participate in day-ahead planning and present their generation schedules day ahead, their schedules do not involve the short term variations. Before 10:30 the generators

have to notify their generation schedules for the every hour of the next day. If the predictions for wind speed or time etc. change, they have limited opportunities to inform the system or market operator. That situation increases the cost of real time balancing. As creation of an intra-day market is not planned, some flexibility to revise the schedules not only helps the generators but also may contribute to reduce balancing costs. Furthermore, establishment of an intra-day market may be considered.

5.4. The structure of Market Financial Settlement Centre (MFSC)

MFSC will be the responsible authority to settle the participants in the planned FIT mechanism in addition to its main responsibility for the financial settlement of the balancing and settlement market. MFSC will collect the money from the suppliers who are obliged to purchase renewable energy in proportion to their total consumption and will transfer it to the generators.

Appointment of MFSC for settlement of the support system is reasonable. However, there are some points that should be considered by the government. First of all, the recent settlement process managed by MFSC involves some problems which lead to delays in delivering of payments. Besides, it is hard to say that the transparency level of the market is enough. The new designed balancing and settlement market has been functioning since the first day of December of 2009. However, the market data except for prices and some quantities have not been shared with the public until now. It is also a matter of doubt whether MFSC or other related organizations will be able to execute the penal provisions if the obliged suppliers delay to pay for their requirements. Besides, since it is a body of state owned transmission company, whether MFSC will be able to behave independently is also under suspicion. To recapitulate, the autonomy of MFSC should be ensured not only for a well-functioning balancing and settlement market but also for promotion of renewables.

6. On the wind energy policy of Turkey: medium-term/long-term priorities

6.1. Intermittency of wind energy

The output of wind energy fluctuates depending on natural conditions. It shows seasonal, daily or hourly fluctuations. The inherent intermittent nature of wind leads to quality problems such as frequency variations or voltage dips in addition to balancing issues. Therefore wind intermittency is a crucial issue requiring detailed studies. Before, it was considered that only a small amount of intermittent capacity was permissible on the grid. However, some experiences as the Western Danish region prove that a big amount of intermittent capacity on the grid is applicable in some circumstances [31]. Even though intermittency is still a significant challenge, there are some means to reduce the gravity of this challenge. It should be noted that variability is not a totally new issue for grid management since both electricity supply and demand are variable.

Recently, the total share of wind energy in total installed capacity of Turkey is only nearly 3% and the share of other intermittent sources is so limited. As a result, operation of the transmission grid is not so challenging with that capacity of variable sources. However, the current trend displays that the capacity of wind energy will rapidly rise in near future. That may pose significant challenges in managing the transmission grid. So, the measures will appear on the agenda of policy makers very soon.

Interconnection with other grids is one of the methods to deal with intermittency. Western Denmark poses an example for that. It handles a significant amount of wind energy since it has good interconnectors with other grids as the Swedish, Norwegian and German grid. Thus, it accesses to Norwegian hydro-power as reserve capacity [31]. Besides, since Denmark is a part of Nord Pool electricity market it can sell the excessive supply in the market and can purchase electricity produced in other regions of the pool in the times of supply shortage.

Table 7
The ratio of electricity generation by wind in overall electricity generation for selected EU member or candidate South East Europe countries.

	Generation by wind (GWh) (2008)	Total gross generation (GWh) (2008)	Ratio (%) (2008)	Installed capacity (wind) (MW) (2009)
Bulgaria	122	45,037	0.3	177
Croatia	40	12,326	0.3	28
Greece	2242	63,749	3.5	1087
Romania	4	64,955	0	14

Source: Eurostat [32], EWEA [33].

Interconnection of grids is a powerful strategy since it increases the number of available options and provides significant value as lower cost balancing power stations can be accessed helping for a more efficient utilization of resources [18]. Besides, it reduces the aggregate variability of wind energy. It also reduces balancing costs. Turkey opted the opportunity of interconnection with other grids to limit the risk stemmed from variability of wind energy and recently the interconnection with Greece and Bulgaria has been ensured.

As a candidate for the EU, Turkey may pursue policies to precipitate the creation of the planned organized electricity market in the South East Europe and to be a member of that market. The interconnected grid and established regional market not only provide an opportunity to handle the intermittency but also help to trade the excessive wind energy supply. As can be seen in Table 7, total electricity generation from the wind energy had a small share in total electricity generation in four South East European countries [32,33].

Even though the total share of wind energy is currently low in the electricity industries of South East European countries, it may be claimed that that share may rise soon as a result of the EU's energy policy on renewables. Therefore, dynamic analyses about that topic are required.

6.2. Ancillary services

Ancillary services have an important role in balancing electricity supply and demand under the required quality standards. Deployment of sufficient reserve capacity to maintain the reliability of electricity system is unavoidable. The main reserves used for ensuring balancing of the system in the short time as a part of ancillary services are primary reserves and secondary reserves. Following the state of instability in the system, the primary reserves come online within seconds, reach its maximum capacity value within 30 s and have the ability to continue to operate at least 15 min. Secondary reserves come online in 30 s and replace the primary reserves.

A high share of wind energy capacity makes the balancing complicated due to supply changes as a result of variable nature of wind. Therefore, importance of ancillary services increases in an electricity system including a big ratio of wind energy.

Since the total wind weight in the total electricity installed capacity of Turkey is low and there are many state-owned or long term-contracted generators in the market, maintaining the security and balance of the system is not a significant challenge for now. However, managing ancillary services may be expected to be more significant as a result of current increasing wind energy trend and privatization of some of the generators. In that case, a reliable ancillary services policy will be more crucial.

Table 8
The determined price for primary control reserves.

Quarter	Price (TL/MWh)	Price ($/MWh)[a]
2009–2011	8.34	5.43
2009–2012	1.75	1.06
2009–2013	0.84	0.55
2009–2014	1.07	0.72
2010–2011	0.13	0.09
2010–2012	12.62	8.31
2010–2013	10.73	6.77
2010–2014	2.71	1.87
2011–2011	10.73	6.90
2011–2012	5.39	3.49

Source: EMRA [34].
[a] The exchange rate is calculated for the first day of the period.

Recently, every generator whose capacity is higher than 50 MW and which does not use variable sources has to contribute in primary control. The capacity that has to be leaved as primary reserve by these generators is determined by TEIAS with an upper limit of 5% of total capacity of the generator. An agreement is signed between these generators and TEIAS and a service price for primary reserves is paid to the generators. The price is calculated quarterly by using a formula determined in the regulation for ancillary services. A similar mechanism for secondary control has been designed. Every generator whose capacity is higher than 100 MW and which does not use variable sources has to contribute in secondary control.

The prices as compensation of contributing in primary control are shown in Table 8. A high variability is seen on the table. While the price is 0.13 TL/MWh in the first quarter of 2010, it is 12.62 TL/MWh in the second quarter of the same year. If the prices very close to zero and a high deviation are due to market conditions, that situation may not be evaluated as a problem. However, some market-discouraging applications in operation of the balancing and settlement market are the reasons for volatility and low prices since the primary control prices are determined by taking into consideration of the prices/bids in the balancing and settlement market. Inexertion of penal provisions besides those low and variable prices may create great uncertainties threatening the reliability of the system. Therefore, properly managed and pursued balancing and ancillary services policies are significant especially for a market which is more competitive and contains more variable resources.

6.3. Demand side management

Demand elasticity of electricity has traditionally been low due to some reasons. First of all, electricity is a fundamental necessity for people. Secondly, it has been hard to measure consumptions of electricity users instantly. Thus, electricity users have not responded to the price changes in wholesale electricity markets. However, with development of organized markets and smart metering systems, measurement of electricity consumption for small periods has been possible.

The most serious problems stemming from wind power intermittency occur during the peak-load hours. Reducing total electricity consumption by the help of demand side response is a significant option to cope with intermittency in peak hours. If the marginal load peak price is higher than the utility of a customer from the delivered electricity, that consumer might prefer to decrease his/her demand at that period. Even, the big consumers may sell some portion of the energy they purchase via long-term contracts if convenient market rules are defined. Consequently, as a result of demand side response to high prices when total generation has the possibility to come out short to meet the total demand, stability of network may be ensured. Besides, a grid operator can obtain an economic benefit paying to a customer to reduce the electricity consumption instead making payment to a generator to supply more electricity since the generation cost can be very high in peak periods [35]. However, in practice, contributions from demand side response in many countries have been relatively small with some exceptions [31].

Although the contribution from demand side management has been anticipated as low, big customers' or aggregation of households' encouragement to participate in the market may produce desirable outcomes to overwhelm intermittency of wind energy. Turkish balancing and settlement market presents some opportunities for big consumers to participate in the market. However, the actual amount of consumer participation is negligible. A well-designed system encouraging the consumers to respond the price changes may be powerful to cope with the intermittency in the future. Nevertheless, it seems that a comprehensive contribution from demand side management is unlike in the short run due to technical and financial reasons.

6.4. Promotion of research and development

Decreasing the level of dependence to abroad is mentioned as one of the reasons why Turkey should support wind energy and other renewables. In this framework, if Turkey creates a nature encouraging the utilization of wind energy but not enabling technological development of the sector within the country rather than importing all the turbines and other equipment, the overall result cannot be assessed as a success. The diversification of sources or countries may be ensured within that kind of structure. However, the dependence to abroad still continues. Even though it is reasonable to import the technology from abroad if the share of wind energy is too low, it is apparent that Turkey has a great potential to increase the utilization of wind energy. Furthermore, since wind energy potential of Turkey is very high, it may create a comparative advantage in production of wind energy technology. Therefore, Turkey's aim regarding wind energy policy should not be only to increase the share of wind energy in its energy resources but also to create domestic wind energy technology manufacturing industries. That is, the implemented incentive system should stimulate research and development regarding wind energy technologies.

In fact, one of the main motives behind the support of renewable energy sources by pricing or quota systems is to contribute to declining of costs from that kind of technologies by covering the technological costs. Encouraging import of all material from abroad is not one of these main aims. Hence, while adopting a support mechanism Turkey should pursue a policy ensuring technological development of these industries as well. That requires intervention of universities, TUBITAK and other research institutes. A comprehensive, stable and determined policy agenda besides general awareness is the main pillar for the success of technological development. So, a viable nature should be created for use of existing funds and allurement of new financial resources for research and development investments.

An increased share of wind energy in grid requires more certain forecasts to predict the amount of electricity produced by wind in small periods. That is, improved forecasting methods are essential in an electricity system involving a significant wind energy share. Furthermore, the studies to improve flexibility of power system are necessary for an improved balancing mechanism. Hence, research and development on those issues may improve the reliability of the electricity system in the future.

Currently additional incentive for domestic production is introduced in the law. This additional incentive will be paid to the generators for five years if the equipment is manufactured domes-

tically. This may be helpful to intensify domestic efforts on manufacture of the equipment. However, it is not a direct support to the research institutes or manufacturers. The success of this method can be evaluated after seeing the results of the support mechanism.

Constituting a sound and viable wind energy manufacturing industry creates both domestic and international opportunities. Initially, it creates new job opportunities. Wind development is often credited with creating more jobs per money invested and per kWh generated than fossil fuel power generation [36]. Moreover, expanding global wind energy market as a result of increasing environmental concerns presents an opportunity for exports. Finally, domestically manufacturing of wind turbines may be effective in reducing transportation costs.

7. Conclusion

The diversification of energy supply sources and increasing the share of renewable energy sources in electricity generation are two of Turkey's priorities in the electricity industry. In this framework, wind energy is one of the top issues finding a place on the energy policy agenda of Turkey because of having a great potential to contribute to security of supply, to lower emissions to the environment and to meet the increase in electricity demand. As a result, Turkey introduces policies to promote renewable energy sources. Creation of a competitive liberal electricity market is another priority of the country. Therefore, Turkey faces challenges to pursue policies consistent with all of those aims.

While the recent global economic crash has had some affects on Turkish economy, it has created some opportunities for the electricity market especially for renewables. The predicted electricity supply crisis has been postponed thanks to the economic crisis which reduced electricity consumption of the country. This situation may be used for installation of renewable energy facilities to generate electricity in order to abolish the expected supply problem in the future.

Turkey needs to introduce a comprehensive energy policy and energy agenda including wind and other renewable energy sources. A higher level of coordination between related parties should be ensured in this policy agenda. Furthermore, more reliable and detailed wind energy resource assessments and data banks should be prepared to be able to assess the economic and technical wind energy potential of the country. Finally, the issues stated in this paper should be taken into consideration while developing policies to implement an effective policy regarding wind energy.

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